CHAPTER FOUR

Operational Hints for Glow Plug Engines.

High Revolutions are Important.

Although the above fact has been mentioned before, my readers will doubtless forgive a certain amount of repetition when I emphasise and explain the very vital importance of this characteristic of the glow plug engine. The successful operation of the type is so much bound up with the capability of high revolutions. This not only applies to the type of work given to the engine, but *it affects the propeller, and the engine's design generally*. For instance if we fit a propeller that holds down the high revving properties of the engine, the performance of the engine can never be satisfactory.

If the glow plug engine has a tight fitting bearing or a tight piston, then it will not be able to attain high revolutions. If the porting is constricted the engine cannot take in gas sufficiently quickly for high revolutions, nor can these revolutions be attained if the exhaust cannot get away sufficiently rapidly. An engine may have excellent porting of an ample nature and yet the transfer port can be on the small size, and will undo all the good that a suitable inlet port can give. Designers of the past in this country have always had a tendency on model engines to restrict power output by providing too small porting. Mr. Rankine, the speed boat enthusiast, surprised the model world some years ago by fitting enormous porting to his record-breaking boat engines. The Americans have developed vast ports for some considerable time and yet retained easy starting. It is good to see British manufacturers are now getting down to the virtues of large porting where motors require high revolutions. And our glow plug engines require this feature more than any other

type. In fact they demand it if they are to be a success.

Some readers used to the old slow speed but quite powerful spark ignition engines which they may have operated, think that a glow plug engine should give equal performance at low revolutions. This cannot be so, and we had better marshal our facts, so that we know how to treat our glow plug engines. This high speed characteristic is one of the greatest reasons why some ancient petrol engines with design features that do not permit high revolutions, do not make satisfactory glow plug conversions.

In the case of the spark plug engine, the designer times his spark to occur either early or late, in relation to where the piston is situated near the top of its stroke. Thus, if the spark ignites the gas before the piston comes to the top of the power stroke at T.D.C., the engine will run fast at high revolutions, provided the ports, etc., will allow this.

If the spark is timed to take place after the piston has passed the top of its stroke the ignited gases will give a belated push and the engine will run slowly. There will then be no tendency to knock. If the engine is starting up, or is pulling slowly at low revolutions, and the ignition takes place early, one of two things will occur, unless, of course, the compression ratio is very low. The piston will get a kick back before it has got to the top of its stroke. This may make it reverse the motor's direction of rotation. Readers will know how their engines (petrol) often kick back on starting if they have not retarded the ignition.

If the engine has already started and is running slowly, as described with ignition too far advanced, it will be pulled up in speed through the difficulty with which the piston has to overcome the pressure of the too early blow from the "explosion". As soon as the piston gets over top dead centre it is free to race ahead. In these circumstances the engine runs with a laboured feeling and dead exhaust note. It often knocks, and it certainly knocks its bearings to pieces if this procedure is persisted in.

The glow plug engine has what is in effect permanently early ignition, because as we have already remarked in a previous chapter, there is a glowing plug awaiting the upcoming piston.

In these circumstances, the engine must be going fast to overcome the early ignition, just as in the case of a timed spark ignition petrol motor with ignition advanced.

That is the whole crux of the matter, and the reason why the glow plug engine must be allowed to rev. The engine must then be given a task in the right type of model that will allow it to rev. It must be given a propeller that will allow it to rev. It must be provided with large ports that will allow it to rev. And it must be "free" in rotation, so that it can rev.

In the chapter showing glow plug engines, I have touched on ball races for easy turning, easy fitting pistons and bearings, but without undue leaks, past those bearings and pistons. I need not go into more technical details other than to remark that a glow plug engine will often run at its best with a really "sloppy" piston fit, provided the fit is just sufficient to keep reasonable compression. A diesel on the other hand must have a very close fitting piston. Readers must not judge the two types as one problem. It often happens that a new comer to glow plug operation is not satisfied with his new engine's output. If he would just run it in properly and really free it up all would be well, and his grouse maybe change to a paean of praise.

It should be evident that for a new power modeller. to fit a glow plug engine, which has this revving at high speed characteristic to a model that requires a slow speed pulling type of power, is as silly as to enter a donkey for the Derby.

Fuel tank design for high speed control line models, also boats and cars on the circular course—where centrifugal force affects fuel mixture strength.

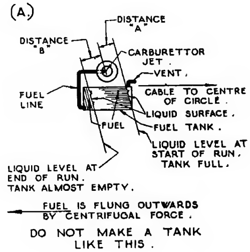
A model which flies around a fixed centre, or a car or

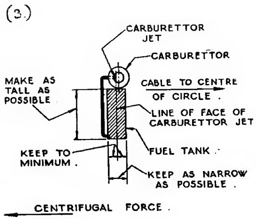
boat which travels around a fixed pole on the end of a line, which is the normal racing procedure, will never keep its engine running satisfactorily throughout its run unless a special fuel tank is fitted.

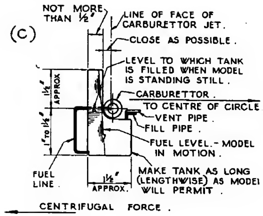
Furthermore, because the glow plug engine is particu-

Fig. 27a, b, c.

The effects of centrifugal force on fuel feed.







SUGGESTED CROSS SECTION
OF TANK FOR MODEL CARS
OR PLANES.

Fig. 27c.

larly touchy over mixture strength, and a rich mixture will over-cool the glowing element, the correct fuel tank is absolutely vital in these circumstances.

I must admit that I have very seldom seen even the stars amongst the stunt control line men in this country flying their large petrol engines for lap after lap running at top revolutions with perfectly consistent firing. There are usually signs of starving, hunting, or rich mixture during the flight. I believe that one of the reasons why the Americans to date hold all the ultimate speed records in aeroplane car and boat field in the model world, is due to the fact that their top liners ensure that the engine gets an even fuel flow throughout the run in spite of the very adverse effects of varying and mounting centrifugal force. How often one sees even at International boat meetings in Britain, erratic running amongst the better men. And yet if their engines were put on the bench they would roar the tank of fuel out without any falling off of speed. At the pond side the report often is, that "Mr. So-and-So got in a few laps at very high speed before bad luck set in and the

motor faded out". It was generally not due to bad luck. It was an unsuitable fuel tank! If you are a betting man and keen to know who will take off the first prize, have a look at the well-known boats and make a special note of those which have fuel arrangements likely to give an even mixture throughout the run as the speed rises.

Fig. 27 (A) shows how the fuel is flung to the outside of the circle and the outside of the tank. *As the model accelerates the fuel will also go backwards as well as outwards.*

If the tank is full at the start of the run or flight, the fuel will have a "head" of liquid equivalent to the distance "A" trying to force itself into the carburetter jet. When the tank empties as the run or flight continues the "head" of fuel will be as shown at "B".

Therefore at the beginning of the run the carburetter has "forced feed" and at the end "suction feed."

This causes the engine to get a rich mixture at the start of the speed run and weak at the end, which is a hopeless state of affairs for consistent power output. Incidentally the average model man makes himself a large flat tank or a large circular tank as shown in the sketch, when he requires a long run by a thirsty engine. He thinks that because he has placed the fuel pick up pipe in the far rear corner he has defeated centrifugal force worries, and if he also leads his pipe line away from the far corner he will overcome surge. He has only mitigated some of the worst of his trouble. He is annoyed because his "hot" engine fades out or misfires, often blaming the manufacturer for an overheating engine, etc. In actual fact he should blame his fuel feed. It is best in these circumstances to take the engine to the bench and if it will roar away well, then rethink out the tank problem! There are of course some canny racing men who have this all set, but I am discussing the average man.

The American Dooling firm explain how, as the speed rises, the centrifugal force creates even more trouble than

the sketch indicates. For the sake of argument, let it be supposed that Distance "A" equals one inch, and Distance "B" also equals one inch. The fuel level will then change 2 ins. during the model's run.

Let us assume that the model is travelling at 100 m.p.h. on a 35 foot radius. This means that due to centrifugal force the effect of the change of "head" from start to finish of the run is approximately 19 times as much as the actual measurement originally given! This would be the same as running the engine on the bench with a fuel tank 38 in. high, with the fuel level 19 in. above the carburetter at the start and 19 in. below the carburetter at the end of the run!

Can any reasonable man expect his poor engine to give of its reliable best without a misfire from beginning to end of the run under these circumstances, without altering his needle valve to compensate?

As our racing aspirant cannot get at his needle valve to alter it once the model is in motion, he must fit a tank that will defeat centrifugal force. What can he do to improve his tank? Fig. 27 (B) gives a clue. A deep narrow tank, fitted below the jet is a good method. In Fig. 27 (C) a sketch shows the principle upon which the racing Dooling tank is made. This tank can be made in a long narrow L shape where a large amount of fuel has to be carried. It seems to work well in practice, for last year the Dooling car created the world's car record of 127 m.p.h., and an aeroplane fitted with a Dooling engine created a propeller-driven model aircraft record of 143.8 m.p.h.

Propellers for glow plug engines.

It should be evident, from the remarks in previous chapters and at the beginning of this chapter, that modellers and manufacturers should fit propellers suitable for high revolutions to glow plug engines. These engines cannot give real results if a normal diameter and pitch propeller as fitted to the slower revving diesel is fitted.

The diameter should be less. The pitch must of course suit the speed of the model, but may, generally speaking, be a little lower than standard.

Most modellers know by now that a propeller or airscrew for aeroplanes is like a revolving aerofoil or wing. It is set at an angle of incidence to its line of forward travel, and it screws its way through the air or water. If the model is travelling fast then the pitch is increased.

If the machine is travelling slowly the pitch is less, because the blades do not go as far in one revolution as when the model is going faster.

A large area wing travels slowly, whereas a small heavily loaded wing travels fast. As our glow plug engine is rotating its propeller fast, the propeller wing or blade must also travel fast. We must therefore fit a small, fast travelling, highly loaded blade, i.e. a small diameter propeller that encourages high revolutions. One must of course be careful not to fit too small a blade area so that the propeller just buzzes around at terrific revolutions and either stalls itself hopelessly in the air, or cavitates in the water.

As a very rough guide I would recommend that glow plug engines are given a propeller with a diameter 1 in. to 1½ in. less than their diesel brothers, with a pitch to suit the speed of the model.

A free flight model travelling comparatively slowly will be best suited by a low pitch propeller. A speed control line model will require a high pitch propeller. A stunt control line model will require a slightly less pitched propeller than the speed model, because although fast, there are a number of occasions when the model loses speed at the top of a loop, etc., and *it is just at that moment* when the propeller must grip the air and keep pulling. Too high a pitch therefore will fail at the critical moment and does not encourage acceleration quickly after a stunt has been performed, ready for the next. The man who throws one stunt quickly after the other is the man who is

worth watching! Colonel Taplin's son used a $7\frac{1}{2}$ in. diam. propeller with a pitch of 14 in. to create his British Class II speed record of 89-95 m.p.h. This meritorious performance, which amazed many modellers, and appeared to annoy others unable to make the grade themselves, judging by their letters to the Model press, was done with a diesel of only 2 c.c., which ran at 7,000 r.p.m. static and probably did 10,000 r.p.m. in the air. This speed from a diesel is above average of course, and a glow plug motor that pulled off a similar performance would probably do a greater number of maximum revs. in the air. It would therefore require a slightly lower pitch, for it would make more revolutions per foot of travel.

To obtain a racing speed like this means that the first few laps are very sluggish until the speed is built up and the revs gained with propeller gripping the air properly. That is why I mentioned that a quickly accelerating stunt machine must have a lower pitch, but not as low as a slow free flight model. A stunt machine is usually well served by a pitch of approximately 8 in. A glow plug motor with its high revolutions will probably give of its best with a pitch of 7 in. or even 6 in. Those are the general figures I have found from experience to be best. Naturally, an engine like the Arden glow plug motor which develops its power at exceptionally high revolutions will take a lowish pitch. If the reader will turn up the description of this engine in Chapter III he will note that the standard pitches given by the firm appear lower than normal.

We know from much practical experience, the best pitches and diameters that suit varying models and jobs, for water work or in the air. The theorist from his armchair will seldom get you a pitch and diameter that will win you a competition. There are too many variables in every model. There is drag for instance.

One model has a wing section that causes more drag than another. One model flies at a flatter angle than

another, and therefore flies faster. Fuselage shape alters the picture in every case. My advice is to set out with your model with a known average pitch and diameter propeller that suits this size of model and the type of engine. Then try slight variations either way, if you are determined to get ultimate performance, until you get the best results. If you just fly for fun then an average prop. will do. But also remember that you can ruin a model's flight or run on the water by fitting a propeller that gives excessive drag in the blades, which will unduly tend to turn the model over, and which in turn makes it fly one wing down and lose climb as a result, in spite of all the power the motor is handing out.

I defy the theorist to provide a winning propeller from pure armchair theory calculations. He will only get near the result, and if he ever does provide a winner, it will be more by good luck than calculation. Because of all the variables in every machine, he can only get near the answer. If you do not believe this, just fit a "hot" engine into a hydroplane and try slight bending of the propeller blades (they must, of course, be made to permit this), and you will be staggered at the different results you will obtain between runs, that a very small alteration of pitch will give. Now try the same propeller on another hydroplane with the same engine, and although the hydroplane may be of the same general dimensions regarding planing surfaces, the propeller will assuredly require alteration. The fact is that even the "full size" designers will produce theoretically correct propellers, and yet find that slight alterations very often improve speed on the boat, the propeller was designed for. I have spent more money than I like to think about on speed boats in this way.

Fortunately in the model world today we have so much experience of certain types and sizes of model aircraft that we have a very shrewd idea of the propeller that will give a *reasonable* performance for any particular model. But if

ultimate climb or speed is the goal, then a little *practical* trial, and error will have to take place, in spite of all the theory man's most abstruse calculations !

Wide blades with square tips suit free flight and stunt models. Thin, narrow blades generally suit high speed models. To give the reader some idea of the rapid advance in models, I can remember that when I flew the first power model to put up a long free flight record after World War I, there was no available data with regard to propellers for such a small model ! Now we have a very complete starting off ground for any particular size power model, and my beard is not yet too long and grey.

Unfortunately, the pitches given by various manufacturers do not always tally with the actual pitch of their

Fig. 28—This 45½″ span model, the " Meteorite ", designed by the author as a kit model, demonstrates the importance of fitting a small diameter, low pitch, high revving propeller for free flight when using a glow plug engine.

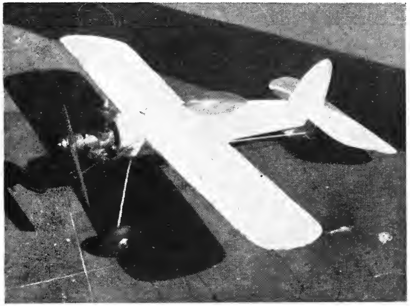


Fig. 29—This little stunt model by the author emphasises the importance of the small, high pitched propeller for control line work. The engine is an Arden .099.

propellers. This may rather confuse a keen model man, who finds that a particular advertised propeller does not come up to the performance he is led to expect. Furthermore, there are some terrible propellers on the market which provide the maximum of drag through the poor contour or section of their blades. Such drag will turn

GUIDE TO GLOW PLUG ENGINE PROPELLORS

C.C. Engine	Diam.	Pitch Free Flight	Pitch Control Line
1½ to 1¾	7½″ to 8″	5″	6″ to 7″
2 to 3	8½″ to 9″	5″ to 6″	7″ to 8″
4·5	10½″	6″	7″ to 8″
9 to 10	12″ to 14″	6″ to 7″	7″ to 9″

over in the air quite a stable model, due to excessive torque, thus leading some people to believe, quite unfairly, that a certain model may be laterally unstable. It therefore behoves modellers to buy well-known makes of propeller with a reputation for accuracy.

Swinging and Positioning the Propeller.

Once the technique of starting has been mastered, *the glow plug engine is very easy to start.* This is made far more simple if the propeller is positioned in the correct place in relation to the engine's t.d.c. and compression.

The propeller should be positioned and tightened on the shaft so that it is coming on to compression near the top of its swing. The operator can then swing the blade right over compression and follow through with that flick of the wrist which gives *power and speed* that is so necessary to obtain good starting. A glow plug engine must have a really vicious swing because it has the "early ignition" characteristic that I have already explained, and is therefore like starting a car with fully advanced ignition. In the case of the car one may possibly break one's wrist unless a quick and determined swing is made under these circumstances. The correct way, of course, is to retard the ignition, but as explained, we cannot do this in the case of the glow plug engine. In any case, the model glow plug engine is so small that it cannot break the wrist, but it can give you a sharp rap over the knuckles ! A glove is a sound fitment for the larger engines.

A properly positioned propeller with good flywheel effect due to sufficient weight gets over the trouble, if a good hearty swing is given.

If the model aircraft is a control line one which drops its undercarriage on take off, and therefore subsequently lands upon its belly, the propeller must be tightened up on its shaft so that the compression is felt as the propeller blade arrives at a horizontal position. When the engine

stops, the propeller will then revolve until compression pulls it up in a horizontal position and the model can land upon its belly without damaging the propeller, especially if the model is flown over grass. I dislike flying models over tarmac in any case, for damage is often done to engines when a crash takes place as it is sure to do occasionally even in the case of the experts who stunt regularly. A cut engine, when upside down in inverted flight, is not always possible to deal with. This horizontal position of the propeller makes starting a little more difficult, because it restricts the free swing somewhat. Fig. 30 shows a model that I specially constructed for this purpose, in which the forward belly of the undercarriage is swept slightly down-

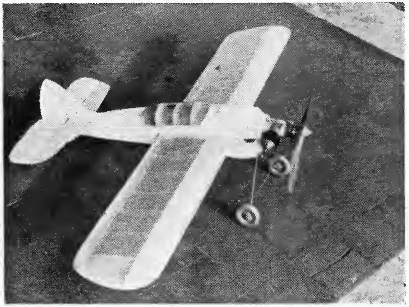


Fig. 30—This control line model drops its undecrarriage after take-off. The propeller is so arranged that when the engine stops the propeller will be horizontal and ready for a " belly landing." Less drag and better stunting is the result.

wards to assist the landing. Such models must have a stunt tank fitted as already described.

Propellers for speed boats and water craft are discussed in my book, "Diesel Model Engines", which also deals with flywheels, etc., for model race cars.

Converting an Existing "Petrol" Engine to Glow Plug Ignition.

Many modellers will want to try out glow plug ignition on their old petrol motor before they invest in a specially designed glow plug motor. What are the chances of success, and what has to be done for this conversion? These are the usual questions asked.

Let me say first, that an old petrol engine will seldom give as good a performance as a specially designed glow plug engine, but there are exceptions to this rule, especially in the case of the more modern high efficiency petrol engines in the larger 10 c.c. class. Most petrol engines can be run with varying degrees of success as glow plug engines. Their efficiency depends upon a large number of factors which the reader will doubtless have weighed up after reading the foregoing chapters. I will therefore address my remarks to the newcomer to the type.

If the compression ratio is reasonably high, and porting is suitably large for fast work, and the plug not unduly shrouded, and *a glow plug of the right type is fitted*, also one of the special fuels mentioned is used, the old petrol motor should function well. Failings in any of the above factors will reduce the efficiency of results in proportion to the seriousness of the failing.

Some of the older petrol engines run so badly and roughly that the experimenter returns to spark ignition and its attendant weight with relief. On the other hand I have had most of my reasonably modern petrol engines running well on glow plug ignition. I cannot stress too strongly that the right plug to suit the engine makes all the difference, and if success is not obtained at first, try another

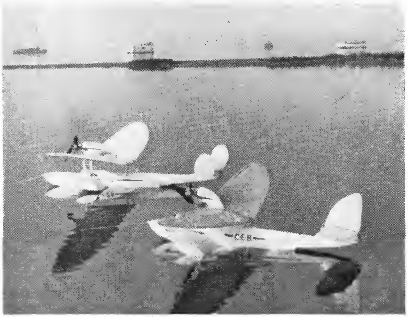


Fig. 31—These flying boats of the author's are flown by an "Ohlsson 60" and a "Majesco" 4.5 c.c. respectively.

plug of a different manufacture. There are only three plugs at the moment on the market, and so it does not financially wreck the experimenter to buy one of each for trial. Very often a long reach plug does the trick with lower compression engines.

If the engine will start, but fails to carry on running when the fuel mixture has been reasonably corrected by adjustment of the needle valve to a greater opening than usual, then try the long reach plug, taking care of course to check that it does not foul the piston at the top of its stroke. If there is any tendency to do this, a spare washer will cure the trouble.

Should the engine run quite well with starting accumulator disconnected after the start, but the power and speed of the engine does not seem to be as good ar better than

in the days of spark ignition, then check up that the propeller is sufficiently small in diameter to allow high revolutions, and failing results *try a different make of plug*. Several of my old engines will start and run on a certain make of plug, but run at considerably greater power output on another make. This means that the element and the internal airspace in the particular plug suits the temperature created by the particular compression ratio of the engine.

When you have got your old motor running at its best, the next thing to do is to remove the contact breaker gear, for it creates useless friction, and the loss in power is greater than many people imagine. Some of the older contact breaker gears were not too clever in this respect.

Finally, do not ruin your celluloid tank. You may want to reconvert one day to "petroil" and spark ignition and want that tank! Make a metal tank, or buy a good commercial stunt tank. Make sure you mount it as described in this book.

Mounting the Glow Plug Engine.

This sounds a dull subject, but it is very noticeable how many people mount their expensive little engines on an absurdly flimsy mount that waves about in the breeze, vibrating horribly. These people often add to this outrage by not tightening up the propeller retaining nut properly.

Vibration destroys good bearings and ruins smooth carburation.

The fuel forms air bubbles which do not permit unimpeded fuel supply in the correct quantities as metered by the needle valve. It is a mere waste of time to take a lot of trouble getting your fuel setting correct if you ignore a rigid engine mount.

There are many methods of mounting an engine and I will not labour the point in this short book other than to remind readers of the absolutely vital necessity of

rigidly mounting the unit. It is unfair on the unit not to do this, for it was not designed to stand up to vast vibration not of its own making. This does not mean that you cannot make your engine and its mount detachable for the crash that a model aircraft is very likely to sustain sometime in its existence. A detachable mount secured by rubber bands makes the engine far less susceptible to damage. I can remember only damaging seriously one engine in my long life of power model flying which dates right back to the first post-war flight after World War I. I would personally never mount my aircraft engines on a purely rigid pair of arms built in one piece with the fuselage. It gives no protection to the crankshaft. I generally use my specially cast detachable mounts in Elektron. These are retained in position by rubber bands or springs, and form a rigid mount for the engine. They can be cowled or left open as desired, and can be detached in a moment. The mount permits packing with wood slips between fuselage and mount to alter thrust line and side thrust when tuning up the model.

A three-ply rigid, but detachable mount, can be made up on somewhat similar lines, and this and other mounts are described in my book, "Diesel Model Engines". The elektron mount casting, suitable for most engines after a little work with a file or hacksaw, can now be obtained from B.M. Models, 43, Westover Road, Bournemouth, for those who like the idea. Incidentally designs of models by myself of aeroplanes and speed boats, are also obtainable from this source.

The Dooling firm of America wisely say in their instruction sheets. "It is entirely possible for you to have the highest powered engine of all and yet throw away that power by improper installation. First, be sure that whatever you bolt the engine to (mounts) are flat. Do not bolt the engine down on a crooked surface as this will tend to put undue strain on the whole engine." Need I add that a rigid

yet detachable non-twisted mount is required for aeroplanes, and a rigid and flat mounting that cannot twist is essential for boats and cars.

Do Not Dismantle Your Engine Unnecessarily.

Again I borrow wise words from Dooling to bolster my remarks. The instruction books says : " Do not dismantle your engine unless absolutely necessary." This is printed in large black type. It is sound advice seldom taken by modellers, and also advice offered by many other model engine manufacturers. In fact, most cancel their guarantee when the engine has been dismantled. To dismantle his engine often seems to be one of the first operations to be undertaken by the new purchaser, " to see how it works."

Sometimes that most dangerous person, the " expert

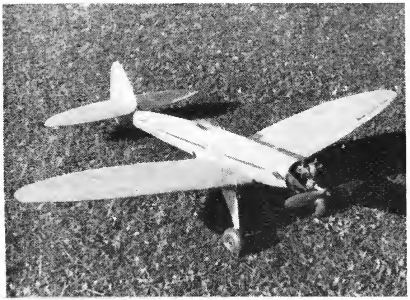


Fig. 32—The author's rigid yet detachable and knack-off-able engine mount is here fitted ta his 4 foot 4 inch span monocoque madel powered by a glow plug engine.

engineering friend," has a go. Much damage is often done by these fits of inquisitiveness. Often, if the owner cannot obtain a start because he has not the technique, he gets someone from a garage to dismantle the poor engine, which is sometimes treated like a tractor engine by the boy who sweeps up the floor. Fundamentally, model engines are the same, but practically very different, and they should be handled by people practised in stripping and erecting these small motors.

Normally a good two-stroke model engine should not require dismantling during its operating life. Many of my engines have never been opened up and yet have given many happy flights or much boat work over a long life.

A two-stroke engine runs better when the gas seals have been made by a little carbon. Tinkering disturbs these. So my advice is leave well alone unless you are experienced and dismantling is a form of pleasure that you must indulge in for your happiness, or unless your engine has a crash when something bends, or it takes in a mouthful of earth and grass. In the latter case this can often be cleared away from the orifices by some petrol and a brush without any foreign matter getting into the works, provided the engine is not rotated until it is clean. Rotating it sucks in the dirt.

How to Stop the Glow Plug Engine.

Glow plug ignition cannot be switched off like spark ignition. Therefore, the safest way is to stop the fuel supply. This can be done in three ways : (*a*) By fitting a small tank which will only supply fuel for a run of limited duration. This is satisfactory for sport flying but not for exact timing of competitions. It has the merit that the model cannot fly away. (*b*) Close the induction pipe so that mixture cannot be drawn in. A flap can be arranged to cover the intake orifice and is spring-controlled, being tripped by a time switch. There are various time switches on the market. The most usual are airdraulic, but are not very accurate to

PRINCIPLE OF FUEL CUT OFF TO STOP ENGINE RUNNING.

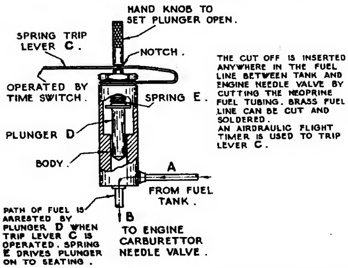


Fig. 33—The above is installed in the fuel pipe line, and forms a reasonably sure method of stopping a glow plug motor if a reliable time switch is fitted.

to within seconds. They are cheap and light. The best I have experienced is the " Elmic."

Camera clockwork timers if obtainable are accurate and useful. The closed flap method has been known to fail, because if the flap, which should have a rubber pad on it to prevent leaks, only half closes the engine runs on for a far longer time and the model is well and truly lost.

(*c*) Fit a fuel cut off in the fuel line operated by a time switch. This method is perhaps the best. It has the advantage of starving the engine for the last few revolutions to a stuttering standstill. This gradual stutter stop gives a model aeroplane time to put its nose into a good gliding angle. If an engine is stopped suddenly when in full cry

with the model's nose climbing to the stars, there is a tendency for the model to get into a series of stalls and a fugoid path, which is highly distressing for its owner to watch (see Fig. 36). Fig. 33 shows the principle of a fuel cut-off. The F.G. Fuel Shut Off Valve manufactured by F. Guest is on somewhat similar lines and is an excellent little instrument.

Mechanical Starting for Large Capacity Engines.

The " early ignition " effect of glow plug ignition makes starting the larger capacity " hot " high compression engines difficult because there is the tendency to kick back. In America many clubs have a communal mechanical starter rigged up from a car starter motor and battery. This is a luxury not often encountered in this now more austere country, but may well be more in evidence as the larger racing glow plug engines become popular over here, as they doubtless will do.

Sir Robert Bland Bird, the well-known vice-president of the Society of Model Aeronautical Engineers, and a very keen and resourceful model enthusiast, has a specially made mechanical electrical starter which can be used to start either aero propellers or a boat flywheel. There is a flexible speedometer-type drive with a chuck at the business end. This takes varying friction heads to suit the different tasks it has to deal with. Thus an airscrew has a large circular flat disc which grips the propeller blades, and a boat or car flywheel is gripped by a small driver disc. I have helped Sir Robert to start his 10 c.c. engine in a speed boat with this instrument, and later in the day to start up an air propeller. All the hard work is taken out of starting, but the job of carting about the heavy gear is no mean feat ! The subject deserves a little careful thought when a modeller is going in seriously for racing engines having a large capacity and high compression.

Otherwise a stout glove and a heavyish propeller, allied to a fearless and vicious swing are the best remedy. For

Fig. 34—The author's "C" class three point suspension hydroplane is now run on glow plug ignition to lighten the planing load.

cars and boats a grooved flywheel with a leather belt of the round section type as supplied by the Singer Sewing Machine Company for their sewing machines is the best method of starting, other than by mechanical starter.

Fig. 34 shows a three-point suspension hydroplane which I fitted with a 14 c.c. ball-bearing Forster engine. Since taking this photograph I have run the engine on a glow plug and methanol fuel, thus cutting the weight of the old ignition gear and also lightening the water loading for faster planing. I use a leather thong to start this engine. Engine bearers must be really stout and of oak to withstand the heavy pull on the thong when starting up a large glow plug engine such as this. I use a McCoy long reach plug on this engine.

Running in and Testing the Engine.

Elsewhere I have emphasised the importance of obtaining a really free engine for glow plug work at its best. A little care is therefore well repaid over the running in period.

This work can conveniently be in two stages where an aeroplane is concerned. The first is on a test stand which can be rigged up on the bench or preferably out of doors where fumes are not troublesome. Care has to be taken with regard to adequate ventilation indoors.

A really large tank of noble proportions is useful for the test stand, but this must not be used to the bitter end when the engine is brand new. A series of short sharp runs are required. Later, long runs with a rather rich mixture are good, followed by a few full-power bursts. During the

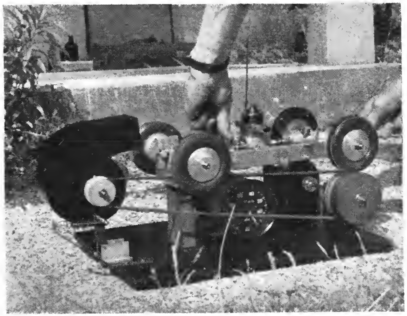


Fig. 35—Mr. Curwen's ingenious test machine records speeds under load of the fan brake driven from the friction discs rotated by the car's wheels.

running-in period I drip a few occasional drops of lubricating oil into the induction port from an oil can whilst the engine is running. Care must be taken not to overdo this for the sake of the plug, but it does help to provide adequate lubrication when working clearances are small and the engine tends to overheat and tighten up. A test stand made from odd pieces of wood can be seen in Fig. 25, Chapter III.

Fig. 35 shows a really scientific home test apparatus which Mr. Curwen, the well-known model race car enthusiast, uses when developing his engines. This enables him to run up his car chassis and take test readings of performance speeds including transmission losses. He is also able to make preliminary fuel mixture adjustments under load. A speedometer is fitted and the engine drives a combined fan and brake through friction discs and the wheels.

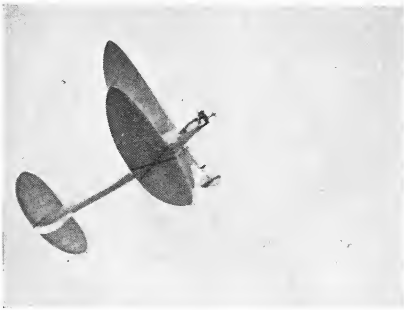


Fig. 36—Climbing to the stars by glow plug ignition. The model is a monocoque by the author.

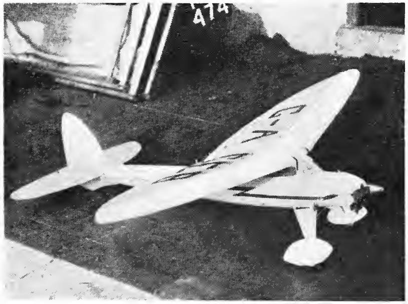


Fig. 37—The Bowden "Satellite", 48 inch span monocoque model keeps construction light and simple because of the glow plug engine.

The engine shown on the test rig is of extreme interest, for it is a combination of diesel-cum-glow plug engine, and is started by spark ignition when running as a diesel, with the power pack removed when the engine is started. The engine is only 5 c.c. and yet it has on numerous occasions been timed to do over 60 m.p.h. on the track. It also drives a model hydroplane. Mr. Curwen says the engine runs very well on a glow plug.

The second stage of running in for model aircraft is done on the ground with engine mounted in the model. This is a very important stage, which should not be shirked by the modeller keen to get his latest creation into the air. It is the stage when installation troubles appear, and it is when the owner gets to know his engine's starting under the much more difficult swinging conditions near the

ground. It is surprising how easy it is to swing an engine when it is comfortably situated at bench height.

Simplicity is a Strong Feature.

The glow plug engine is one of the best types to choose when building monocoque models with their nice streamline form. There is no need to consider the troublesome cutting of holes in the fuselage, or providing trapdoors for electrical ignition, battery, etc., which ruin appearance and reduce strength. This component can be an unbroken smooth shell, planked up direct and with only a few wire hooks protruding. On very small models the undercarriage can be just two spring steel cantilever wire legs. I find these bend too freely on models of 45-in. span and over.

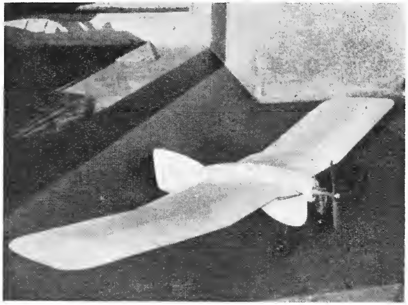


Fig. 38—The author's curious experimental " flying plank " model has no tail. Only a trim tab is fitted to the reflex wing section main plane. Strangely enough the model flies with considerable stability.

In this case I fit a rubber shock absorber undercarriage as seen in the photograph (Fig. 37) of my little monocoque high-wing 48 in. span " Bowden Satellite ", designed for a kit model suitable for the Frog 160 glow plug engine and small diesels up to 2 c.c.

Experimental Models.

Experimental models afford the greatest fun and interest in model building, for they are a test of one's brain storms, and full of the unknown. Alterations can be carried out quickly when glow plug ignition is used, because the engine is merely clapped on to a plain fuselage without any wiring or other installation waste of time. A completely new fuselage if necessary is quickly built.

Water Craft.

The glow plug engine and its brother diesel are both power units particularily suited to model flying boats, float-planes and speed boats.

I have, perhaps, as much experience over the years of this branch of modelling as most people, for I have always taken a keen interest in the water and boats, combining model racing and full-size work. It is an extremely interesting and intriguing type of modelling, for there are dual problems to be tackled as well as the pleasant surroundings that water usually produces.

Electrical spark ignition has always complicated the designer's troubles, and spoilt many a day's fun due to electrical trouble after a ducking, or sea water spray and its corrosive effect on electrical equipment.

Now we have the simple diesel or glow plug engines which give no unnecessary trouble, and allow us to concentrate upon the model's performance. The starting battery for glow plug ignition does not give trouble, for it remains in the operating dinghy or upon the shore if the model is being launched at the pond side. The high-speed

Fig. 39—Try your hand at control line flying from water. It can be done from the bank or shore of a pond or the sea. This model is fitted with an E.D. glow plug engine, and was made by the author.

glow plug engine is very suitable for planing speed boats and hydroplanes, and ideal for the larger flying boats and floatplanes where the diesel is not available in the larger capacity. The glow plug engine gives a light water and wing loading which makes all the difference when operating water model craft. Planing craft have a punch and potency that can never be obtained when loaded up with heavy batteries and coil ignition, etc.

The little diesel is very suitable for the baby water craft models, and the glow plug engine for the medium and larger craft. Models can be smaller and more portable when fitted with either of these engine types, but the size is naturally limited by the type of water they have to operate from. Open inland sea water or lakes can usually be relied

upon to have large " scale " waves even in good weather, compared to a sheltered pond. On the other hand, I think the sea water surroundings are more fun and give greater scope, especially if one has a boat or can beg or borrow one. In these circumstances the larger model is the best because it is always more stable and can cope with rough water better.

The man who is restricted to a pond and has aeroplane leanings can get a great deal of fun from control line flying off water. He has a half circle or more, if prepared to do a little wading, to take off the model. He then flies his aircraft overland for the remainder of the circle. This requires some nice judgment in take-off and landing. If the motor cuts when over land he merely has to give a slight " whip " of the wrist which carries the model on until a landing is made on the water. Believe me, this water

Fig. 40—Peaceful surroundings with a flavour of model activity. The author's " Wee Sea Bee ", seen beside the tender, is powered by a Frog " Red Glow 160."

control lining cuts out any of the tediousness that land control line flying eventually produces.

The design of the model is not as simple as some people may imagine, for the weight of the lines and the inward pull, without the correcting friction of a wheeled undercarriage on land, tends to spoil the beginning of the take-off until the model has got into its stride. A specially long hull for a flying boat is required with a forward water rudder to overcome this. Fig. 39 shows a model I fly control line having these features. I have recently gone over to glow plug ignition on this model and, incidentally, in spare moments have been slowly compiling a book on this intriguing subject of working model water craft. This

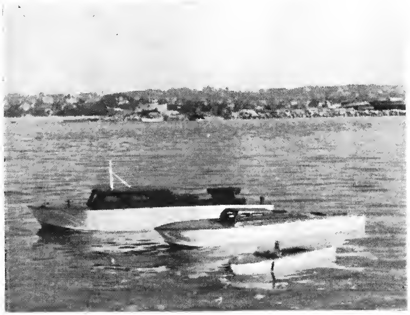


Fig. 41—A bevy of speed boats of the vee bottom, planing type. Foreground, the 19 inch "Sea Swallow"—1 c.c. Frog diesel. Centre, the 38 inch "Flying Fish"—4.5 c.c. Majesco glow plug engine. Rear, 44 inch "Swordfish"—Nordec 10 c.c.

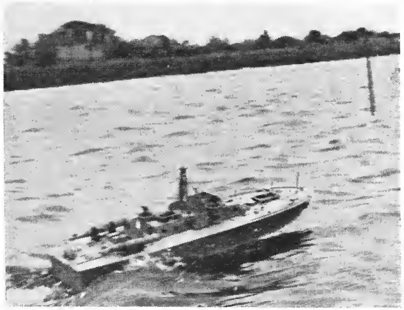


Fig. 42—Action on the water. High speed is just what the doctor ordered for glow plug ignition.

may be some time before it sees the light of day, but I have been fortunate in obtaining many wonderfully interesting photographs of foreign models from all over the world. It is surprising how backward we are in this country concerning flying water models, considering we are a maritime nation surrounded by the sea, and considering what fun there is in the type !

Fault Finding Chart.

There is not much likely to be wrong with glow plug ignition, whereas spark ignition used to be the main source of trouble to the average model man. It is, however, well to have a method in tracing troubles.

(1) *Engine will not start.* Plug has been checked and is seen through exhaust port to be glowing. Starting battery or accumulator is " up ". Trouble probably due to oil

clogging the fuel line, and engine not sucking in fuel properly. Blow line clear and clean needle valve jet. If needle valve is taken out to clean, first make a note of how many turns it was open at the last run. When replacing, make sure that you GENTLY screw down until closed. Then open to " run position ", or perhaps a shade more, choke and start. As engine is choked fuel can usually be seen on finger. If needle is forced the jet seating will be damaged. Some needles are soldered to a collar, and this solder has become unsweated. This will cause starting troubles. Resweat the needle with point on seating in " closed position ".

(2) *Airscrew oscillates back and forth but engine does not start.* Usually when this happens a sizzling noise is heard and vapour will be seen at exhaust ports. This means you have sucked in too much fuel, and mixture is very rich. Close needle valve and swing to clear. The fuel will burn away. Then repeat starting procedure as from beginning and as described in this book.

(3) *Engine stops dead after starting.* Too much fuel has either caused plug to cool off, or a " fuel hydraulic lock " in extreme cases has filled the small space between cylinder head and piston at the top of the stroke. Shut off fuel by closing needle valve gently and, if necessary, turn engine upside down with exhaust port open and drain out fuel from cylinder. Now start again.

(4) *Engine starts and "four-strokes ".* Even a novice can tell a four-stroking engine. There is not that quick even beat. There is a slower beat, more noisy but even, as opposed to misfiring which is irregular. In this case, the needle valve is slightly too far open and mixture is just too rich without actually being so rich as to stop the engine. Reduce needle valve opening slightly by turning clockwise which gives less fuel and more air.

(5) *Engine misfires and slows down, but does not stop dead.* The mixture is too weak. Slightly open up the needle valve

by turning anti-clockwise thereby unscrewing, until engine runs at maximum revolutions.

(6) *Engine vibrates unduly.* Engine may be loose on mount, or mount may be flimsy. Airscrew or flywheel may not be balanced. Test balance by placing on a rod and rotating. Propeller should stop at varying places after each rotational swing. If it always stops one blade down, that blade is too heavy. Sandpaper or reduce by filing, taking care that the offending blade is kept to its aerofoil shape. This is a common fault, and I have known even some moulded plastic propellers to be out of balance, although this is not normally expected, for they all come from the same mould. Unbalanced flywheels have to be drilled and lightened in the heavy part. A badly carved propeller with uneven blade contour can cause bad vibration. Vibration upsets fuel flow by causing bubbles in the fuel tank and line. It also very speedily ruins bearings. I recently had a new " full size " outboard motor from a famous firm which had undue vibration. I took it back to the firm who found the flywheel had somehow been fitted to the engine without being previously balanced. This had caused bad wear in the mainbearing in a very short period. As soon as the flywheel was drilled and balanced the motor ran like a little clock.

(7) *Engine is stiff to turn.* This often happens on glow plug engines on first starting for the day, because the sticky castor oil gums up the engine. Suck in liquid fuel for a few " choked " turns. This will wash away the gummy deposits. Now close the needle valve GENTLY and clear rich mixture away before starting by swinging. Then start up in the ordinary way.

(8) *Engine becomes damaged and out of true.* It will be difficult to turn at one point of its revolution. There may have been a crash, or even no crash, and yet damage may have occurred through a careless owner gripping the engine in a vice when testing instead of mounting properly to a

test stand or in the model. The vice squeezes and distorts the crankcase which is naturally not designed to be crushed. Some engines require cylinder holding down bolts (where these are fitted) to be taken up after they are run in when new. If these bolts are not tightened gently *and evenly*, they will cause the cylinder to draw up out of line and cause the piston to bind.

(9) *After a crash.* Make sure engine turns easily and quite freely. If it binds, the crankshaft has probably been bent. Send to makers. But before turning the engine to test for freeness, make sure that dirt and grit has not got into and blocked the intake or exhaust ports, because if there is dirt present it may be sucked into the engine when it is turned. In this case first clean dirt away and finish with petrol and a brush taking care no dirt is washed into the ports. If this is impossible, the engine must be dismantled without turning it. Before you do this make sure you know how to remake gasket joints, etc., and be careful to replace piston and cylinder in the correct way, or the piston deflector hump will not function.

(10) *Engine is bad starter and runner.* If plug O.K. and fuel correct, this is often due to air leaks past worn bearings, or badly fitted gaskets, or a worn piston. The makers are the best people to tackle this trouble except in regard to making new joints which is easily done by the owner. There must be good crankcase compression on a "two-stroke" for the engine to inhale its charge and to pump that charge into the cylinder via the transfer port. See Chapter I—How a two-stroke works. The piston must, therefore, be a sufficiently good fit and not blow too many bubbles when put on compression.

(11) *Loose propeller or flywheel.* This is a far more frequent fault with new owners than many people imagine. Make sure the propeller is kept tight and test frequently between runs. Be careful, however, not to use too large a spanner and force the nut or the thread can be stripped.

(12) *Plug will not glow.* This may be a burnt-out plug r a damaged element where it joins the plug body. Or an xhausted battery, or bad contact by crocodile clips to lug or "earth" may be the cause. Use good robust exible leads of large diameter, for like a large bore water ipe, heavy duty leads pass the flow of current easily. lways have a new and known good plug handy to test he "dud plug" possibility by elimination as the first nove.

PUBLISHER'S ANNOUNCEMENT

Readers of *Model Glow Plug Engines* will be interested to know that Colonel Bowden's *Diesel Model Engines* has been revised and brought right up to date. The book gives details of all the well-known British and foreign diesel engine designs. There are 192 pages and 119 illustrations. The price is 5/-.

R. H. Warring is no stranger to model aircraft fans. The publishers have commissioned him to write a series of three books on control line flying, entitled *Control Line Flying*, *Stunt Control Line Flying*, and *Speed Control Line Models*. The first two are now available and the third is in preparation.